**CS 428/528**

**Instructor: Anand Seetharam**

**Homework 5: Network Layer**

**Problem 1 (50 points)**

Consider the following network. With the indicated link costs, use Dijkstra’s shortest-path algorithm to compute the shortest path from

1. x to all network nodes.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Step | N’ | D(t), p(t) | D(u), p(u) | D(v), p(v) | D(w), p(w) | D(y), p(y) | D(z), p(z) |
| 0 | x | ∞ | ∞ | 3, x | 6, x | 6, x | 8, x |
| 1 | xv | 7, v | 6, v |  | 6, x | 6 , x | 8, x |
| 2 | xvw | 7, v | 6, v |  |  | 6, x | 8, x |
| 3 | xvwy | 7, v | 6, v |  |  |  | 8, x |
| 4 | xvwyu | 7, v |  |  |  |  | 8, x |
| 5 | xvwyut |  |  |  |  |  | 8, x |
| 6 | xvwyutz |  |  |  |  |  |  |

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b) t to all network nodes.

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| --- | --- | --- | --- | --- | --- | --- | --- |
| Step | N’ | D(u), p(u) | D(v), p(v) | D(w), p(w) | D(x), p(x) | D(y), p(y) | D(z), p(z) |
| 0 | t | 2, t | 4, t | ∞ | ∞ | 7, t | ∞ |
| 1 | tu |  | 4, t | 5, u | ∞ | 7, t | ∞ |
| 2 | tuv |  |  | 5, u | 7, v | 7, t | ∞ |
| 3 | tuvw |  |  |  | 7, v | 7, t | ∞ |
| 4 | tuvwx |  |  |  |  | 7, t | 15, x |
| 5 | tuvwxy |  |  |  |  |  | 15, x |
| 6 | tuvwxyz |  |  |  |  |  |  |

1. v to all network nodes.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Step | N’ | D(t), p(t) | D(u), p(u) | D(w), p(w) | D(x), p(x) | D(y), p(y) | D(z), p(z) |
| 0 | v | 4, v | 3, u | 4, u | 3, u | 8, u | ∞ |
| 1 | vx | 4, v | 3, u | 4, u |  | 8, u | 11, x |
| 2 | vxu | 4, v |  | 4, u |  | 8, u | 11, x |
| 3 | vxut |  |  | 4, u |  | 8, u | 11, x |
| 4 | vxutw |  |  |  |  | 8, u | 11, x |
| 5 | vxutwy |  |  |  |  |  | 11,x |
| 6 | vxutwyz |  |  |  |  |  |  |

Show how the algorithm works by computing a table similar to Table ­­4.3.

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A picture containing boat, skiing, small, table

Description automatically generated

**Problem 2 (50 points)**

Consider the network shown below, and assume that each node initially knows the cost to each of its neighbors. Consider the distance-vector algorithm and show the working of the algorithm till it converges. You need to show all the steps (i.e., how the tables are being exchanged between the nodes and how they are being updated). You will not be given credit for just writing the final answer.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | U | V | X | Y | Z |
| U |  |  |  |  |  |
| V |  |  |  |  |  |
| X |  |  |  |  |  |
| Y |  |  |  |  |  |
| Z |  |  |  |  |  |

A picture containing photo, clock, different, skiing

Description automatically generated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **U**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | ∞ | ∞ | ∞ | ∞ | ∞ |
| X | ∞ | ∞ | ∞ | ∞ | ∞ |
| Y | ∞ | ∞ | ∞ | ∞ | ∞ |
| Z | ∞ | ∞ | ∞ | ∞ | ∞ |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **U**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 7 |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **V**  **table** | U | V | X | Y | Z |
| U | ∞ | ∞ | ∞ | ∞ | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | ∞ | ∞ | ∞ | ∞ |
| Y | ∞ | ∞ | ∞ | ∞ | ∞ |
| Z | ∞ | ∞ | ∞ | ∞ | ∞ |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **V**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | 3 | 5 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **X**  **table** | U | V | X | Y | Z |
| U | ∞ | ∞ | ∞ | ∞ | ∞ |
| V | ∞ | ∞ | ∞ | ∞ | ∞ |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | ∞ | ∞ | ∞ | ∞ | ∞ |
| Z | ∞ | ∞ | ∞ | ∞ | ∞ |

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| --- | --- | --- | --- | --- | --- |
| **X**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Y**  **table** | U | V | X | Y | Z |
| U | ∞ | ∞ | ∞ | ∞ | ∞ |
| V | ∞ | ∞ | ∞ | ∞ | ∞ |
| X | ∞ | ∞ | ∞ | ∞ | ∞ |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | ∞ | ∞ | ∞ | ∞ |

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| --- | --- | --- | --- | --- | --- |
| **Y**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Z**  **table** | U | V | X | Y | Z |
| U | ∞ | ∞ | ∞ | ∞ | ∞ |
| V | ∞ | ∞ | ∞ | ∞ | ∞ |
| X | ∞ | ∞ | ∞ | ∞ | ∞ |
| Y | ∞ | ∞ | ∞ | ∞ | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

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| --- | --- | --- | --- | --- | --- |
| **Z**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **U**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **U**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 7 |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **V**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | 3 | 5 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **V**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **X**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **X**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Y**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | ∞ | 6 | 2 | ∞ | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Y**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Z**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | ∞ | 2 | ∞ |
| V | 1 | 0 | 3 | ∞ | 6 |
| X | ∞ | 3 | 0 | 3 | 2 |
| Y | 2 | ∞ | 3 | 0 | ∞ |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Z**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **U**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **U**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **V**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 7 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

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| --- | --- | --- | --- | --- | --- |
| **V**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **X**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 7 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **X**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Y**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 7 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 7 | 6 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Y**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Z**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 7 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Z**  **table** | U | V | X | Y | Z |
| U | 0 | 1 | 4 | 2 | 6 |
| V | 1 | 0 | 3 | 3 | 5 |
| X | 4 | 3 | 0 | 3 | 2 |
| Y | 2 | 3 | 3 | 0 | 5 |
| Z | 6 | 5 | 2 | 5 | 0 |